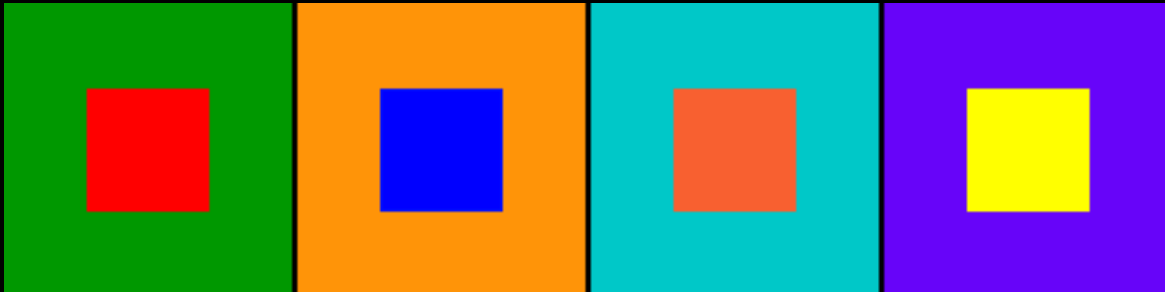


COLOR VODOO #4

COLOR LOGIC



JILL MORTON

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Updated 2008

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for Virginia Daniels Morton

About this PDF

Introduction

How to Use Adobe Reader (Acrobat)

Computer Colors

About Printing

About this PDF - Introduction

This publication has been developed and created to be viewed on-screen, as a PDF.

Due to the variety of monitors and printers currently in existence, there will inevitably be differences in color from screen to screen, and if printed, from printer to printer.

How to use Adobe Reader

Adobe Reader, formerly known as Acrobat, gives you exceptional control in accessing the information in this publication. The following tips are provided to assist you.

Viewing Options

Control the viewing size of the pages in this publication by selecting any one of the options under **View** on the menu bar or any of the page buttons on the tool bar. Options include full magnification, fit the page in window, fit the visible width of the page in window, and other selections.

The zoom-in (magnifying glass) icon on the tool bar can be used to zoom in and out of any area on a page.

Navigation and Bookmarks

Click on the “Pages” or “Bookmarks” tab at the upper left area of the window that displays this publication. It will open icons of each page. Click on any item to link directly to the page.

Use the triangular and arrow tip buttons at the top or bottom of a page to view the next page, the last page or the previous page. You can also return to “the previous view” or go to, the first or last page.

How to Find Things

Click the find tool (binoculars) on the command bar, or choose Edit > Find on the menu bar. A dialog box will appear. Enter the text to be found and click “Find.” When the program finds the text, the page containing the text is displayed with the text highlighted. If you want to find more occurrences of the text, select “Find Again” in the same dialog box.

Computer Colors

This publication was designed for electronic distribution and computer viewing. The layout, fonts and colors were chosen for this environment. Every effort has been made to reproduce colors accurately. All illustrations were prepared on a system with full gamma correction and color synchronization.

16 - 24 bit color, a high quality monitor and fully corrected gamma deliver the best results.

Note!

Some Windows PCs do not have built-in color correction and typically require a video or graphic card for accurate color readings and full gamma correction. Color distortions may also be caused by anti-glare screens.

About Printing

This publication was designed for on screen viewing using the RGB color model. Printers use the CMYK (cyan, magenta, yellow, black) color model. Therefore, colors on your computer monitor will appear different when printed with CMYK inks.

Other Printing Issues

Printing PDFs is an easy task on inkjet and all true postscript laser printers.

Warning: Printing this publication may consume a large quantity of ink.

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Today we see more images in a day than our early civilized ancestors saw in a lifetime. Historically, the technology for printing and paper making began in the ninth century in China. By the fifteenth century, Europeans had developed print-making for the production of religious icons, playing cards and books. The technological advances of the nineteenth and twentieth centuries have provided us with unlimited tools for communicating visual form. Consequently, we are bombarded with images from books, magazines, newspapers, film, television, the Internet, and last but not least, art museums and galleries.

What we see and how it was designed is not happenstance. There is a theoretical history to visual art which equals the development of theories that have contributed to modern science and technology.

Color theory is part of formal aesthetic principles which have evolved over 30,000 years of Western civilization. Beginning in the Paleolithic era, cave drawings are testimony to the first organization of visual form and color palettes. The art of the earliest civilizations of the three river valleys, the Tigris, Nile and Euphrates, contributed to the evolution of visual theories. Their legacy of mosaics, frescoes, sculptures, architecture and other forms continues to inspire the arts today.

The pivotal moment in the development of the arts in Western civilization occurred in Greece. From literature to architecture, the ancient Greeks provided the foundation for all the art that followed. Of interest with respect to color, is that the triumphant architectural monument, the Parthenon, was polychromed. Today only the raw stone surfaces linger as evidence.

The technical analysis of color began with Sir Isaac Newton's discovery in 1666 that sunlight contains all the colors of the rainbow. He also developed the first color circle. Other early color pioneers were Goethe, Schopenhauer and Chevreul. In the early twentieth century, several members of the Bauhaus school of art and industrial design dedicated themselves to a formal analysis of color. The work of Johannes Itten and Josef Albers continues to form the foundation of most of color theory as we know it today.

This publication presents a pictorial guide to color design theory. The definitions and theories are intended to be departure points for successful color compositions and are not intended to be rigid absolutes. *Color Logic* is divided into three sections: color terminology, color harmony and color effects.



DEFINING COLOR

INTRODUCTION

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INTRODUCTION

80% of the brain is dedicated to processing visual information. Color and form are the two basic elements in this communication. It is said that form affects the intellect and color affects the emotions. Another difference worth noting is that form refers to a tangible entity. We know that a rectangular shape has sharp edges. If an object is small, we can assume that it is light. Consequently, we can easily describe form with a wide range of precise terms such as geometric, curved, concave, convex, large, small, heavy and light. By contrast, we can't put a color in our hands and feel it, weigh it, smell it or taste it. Color is purely visual.

An accurate definition is:

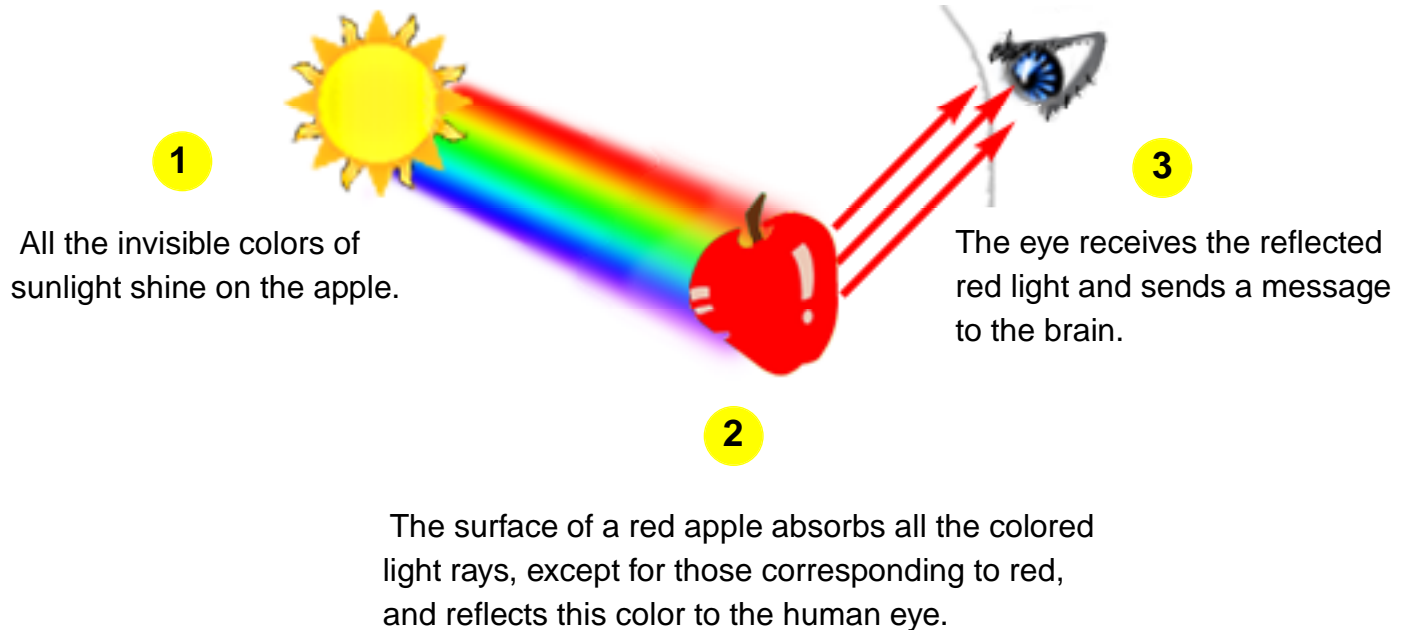
Color is the visual effect that is caused by the spectral composition of the light emitted, transmitted, or reflected by objects.

Fortunately, although color is intangible and perhaps more emotional, the English language does provide us with an adequate vocabulary to describe its properties and related theories. The author has used American English spelling and terminology and recognizes that certain terms may be different in other English speaking countries and that scientists may employ a different color vocabulary. For example, most artists in the United States use the term "saturation." This characteristic is also known as "chroma." When scientists analyze the color of light, saturation and chroma are not the same. Nevertheless, the terms are valid in the fine arts.

In conclusion, a basic understanding of color terminology is the first requirement of color theory. The analysis of color harmony and behavioral characteristics in subsequent parts of this publication will be built upon this foundation.

HOW WE SEE COLOR

Color originates in light. Sunlight, as we perceive it, is colorless. In reality, a rainbow is testimony to the fact that all the colors of the spectrum are present in white light. Light goes from the source (the sun) to the object (the apple), and finally to the detector (the eye and brain).



COLOR SYSTEMS

Surface Color



Subtractive Color

An indirect mixture of reflected light

The local color of tangible objects, such as lemons, leaves, fabrics, paint, human skin and hair, results from the light they reflect after their surfaces absorb (or subtract) light rays. The surface of all colored objects consists of organic or chemical pigments. Different pigments possess different sensitivities to light. Consequently, they absorb only some portions of the light and specifically reflect others.

All colors mix to yield black or a dark neutral color. The absence of color is white.

Light



Additive Color

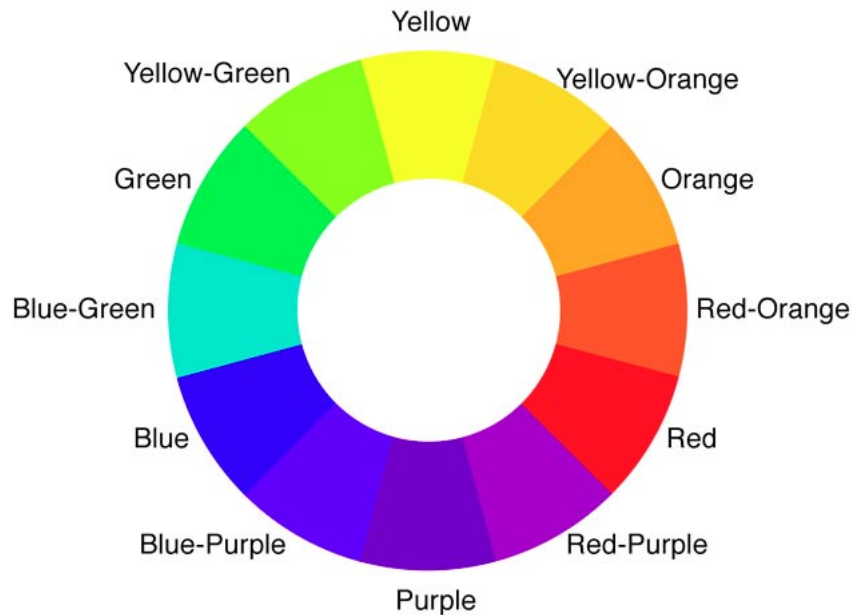
A direct mixture of light

In additive color systems, the eye receives the sum of the light energies, the colored light, that exists in one place. Sunlight is evidence of the purest form of this. Other examples can be found in the projected light that is emitted from a television screen, computer monitors and theatrical lighting.

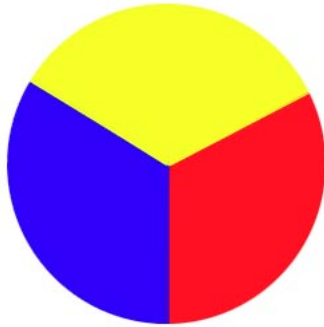
All colors mix to yield white. The absence of color is black.

THE COLOR WHEEL

A color circle, based on red, yellow and blue, is traditional in the field of art. Sir Isaac Newton developed the first circular diagram of colors in 1666. Since then scientists and artists have studied and designed numerous variations of this concept. Differences of opinion about the validity of one format over another continue to provoke debate. In reality, any color circle or color wheel which presents a logically arranged sequence of pure hues has merit.



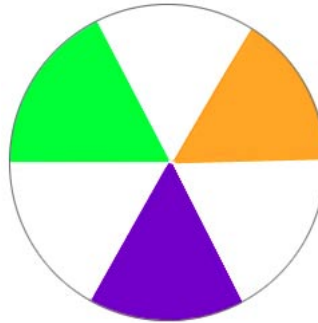
PRIMARY, SECONDARY & TERTIARY COLORS



PRIMARY COLORS

Red, yellow and blue

In traditional color theory, these are the 3 pigment colors that can not be mixed or formed by any combination of other colors. All other colors are derived from these 3 hues.



SECONDARY COLORS

Green, orange and purple

Colors formed by mixing the primary colors.



TERTIARY COLORS

Yellow-orange, red-orange, red-purple, blue-purple, blue-green and yellow-green.

Colors formed by mixing primary and secondary colors.

Primaries and Secondaries - Other Color Systems

Color as Light-Additive Color



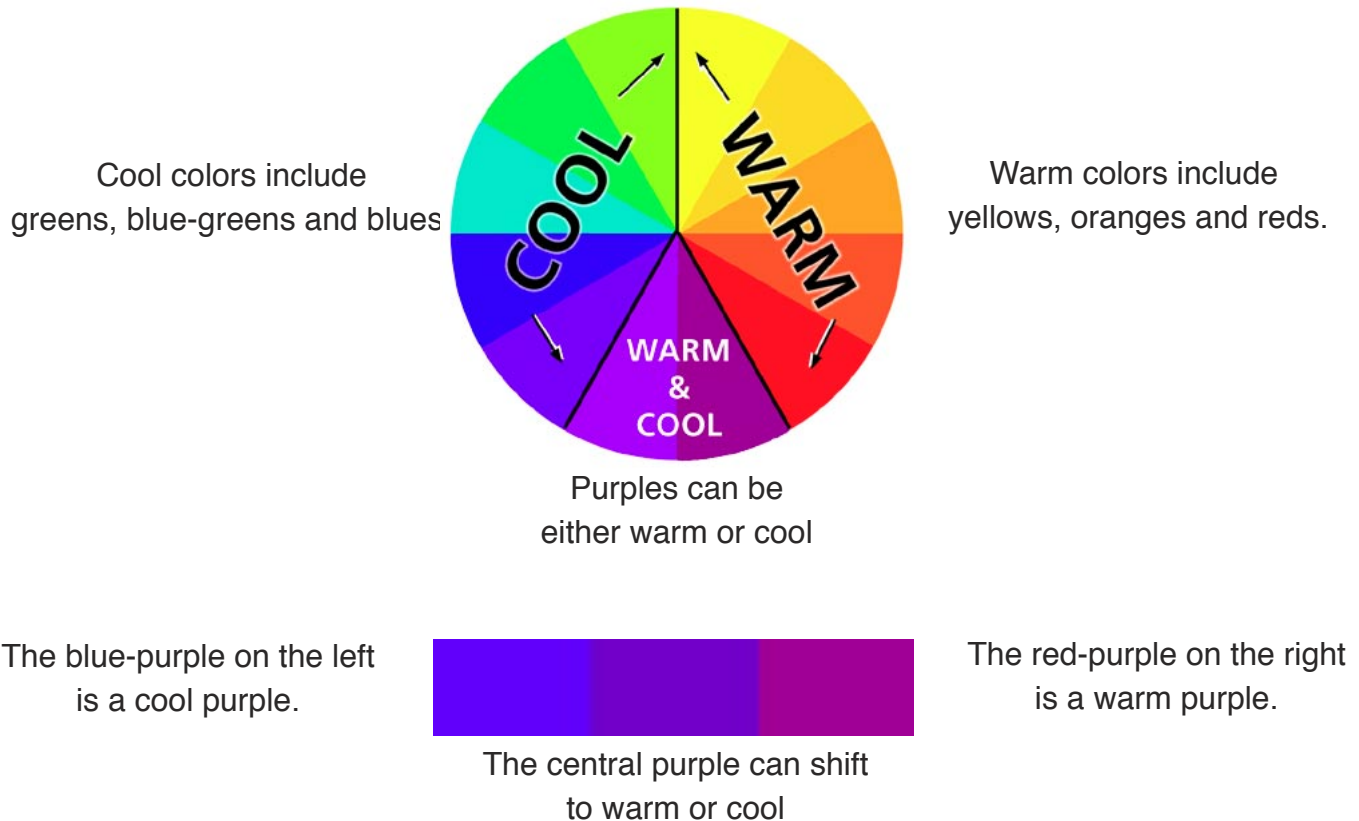
Scientists recognize the light primaries of red, green and blue. When combined, red and green light rays produce yellow, blue and green produce cyan, red and blue produce magenta. This color model is used in computer monitors, television sets, and theatre.

Print Colors

Printers depend on a different set of primaries: cyan, magenta, and yellow, the secondary colors of the additive system.

WARM & COOL COLORS

Colors can be classified as warm or cool.



Variations of warm & cool colors

Further temperature distinctions can be made for specific colors.



A range of blues, from a warm purple-based blue at the left to a cool green-based blue at the right.

Compare the paint hues, Ultramarine Blue, a warm blue, and Phthalocyanine Blue, a cool blue



A range of reds, from a warm yellow-based red at the left to a cool blue-based red at the right.

Compare the paint hues, Cadmium Red Light, a warm red, and Alizarin Crimson, a cool red.



A range of yellows, from a very warm yellow at the left to a cool yellow at the right.

Compare the paint hues, Cadmium Yellow Medium, a warm yellow, and Cadmium Yellow Light, a cool yellow.

More variations of warm & cool colors

Greys

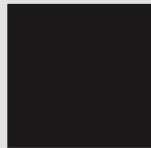
Warm grey



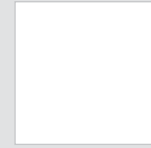
Cool grey

These greys range from warm grey at the left to neutral grey in the middle to cool grey at the right.
The neutral grey is "achromatic" and the warm or cool greys are "chromatic."

Interpretations of Black and White



Black absorbs all light rays and reflects none.
Therefore, black can be considered warm.



White absorbs no light rays and reflects all.
Therefore, white can be considered cool.

*Consider the fact that a black shirt, worn on a hot summer day, absorbs the sun's rays and is warm.
A white shirt reflects the sun's rays and is cool.*

THREE BASIC ATTRIBUTES OF COLOR



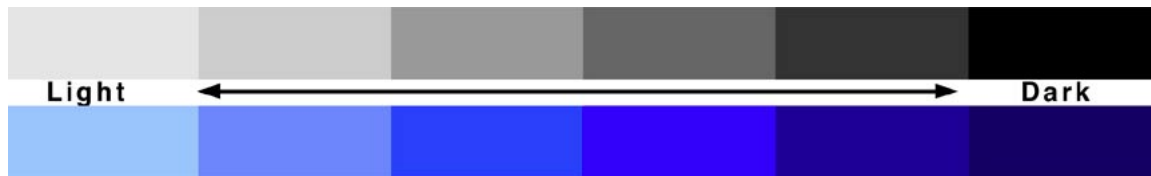
Hue (or Color)

The specific color, for example, red or blue.



Saturation (Chroma or Intensity)

The degree of purity of a color.



Value (Brightness)

The degree of lightness or darkness of a color.

Hue or Color

Hue or color refers to a specific visual effect – for example, bright pink or dark blue. The Universal Language and Dictionary of Names includes 7,500 color names. The human eye can see 10 million colors. Older computer systems generate 256 colors (8-bit), newer computers are equipped with 64 thousand colors (16-bit) and the highest quality systems deliver 16.7 million colors (24-bit).



Pure colors are on the center ring; dark versions of the colors are on the outer ring; light versions, on the inner ring.

Hues or colors can also be defined by their specific wavelength of the visible spectrum.
(For example: red = 750-650 nanometers, blue = 480-460 nanometers.)

SATURATION

Saturation defines the degree of purity of a color.

The terms "chroma" and "intensity" also refer to this characteristic.

The higher the proportion of pure chromatic color, the higher the saturation.

The addition of black, white, or another color lowers the saturation.



In each of these examples, the highest saturation is on the left, the lower saturation on the right.

The more intense "parent color" is on the left..... the "muted variation" is on the right.



Light and dark versions of a pure color are also considered to be of lower saturation.

For example, pink is a mixture of pure red and white; deep red is a mixture of red and black.

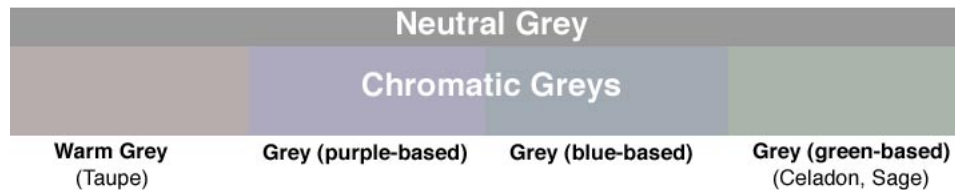
Saturation: Chromatic and Achromatic Colors



Although this greyish-green color is very low in saturation, it exhibits the presence of some color. It is "chromatic."



This color is a neutral grey and has no recognizable color. It is "achromatic."



Very muted colors can be considered to be "chromatic greys."
In other words, these colors are mixtures of grey and a vivid color.

VALUE (BRIGHTNESS)



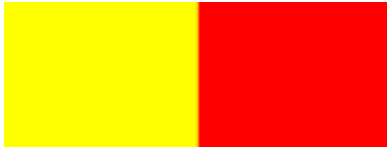
The degree of lightness and darkness of a color is reflected in the value scales above.

A very light color has a high value; a very dark color, a low value.

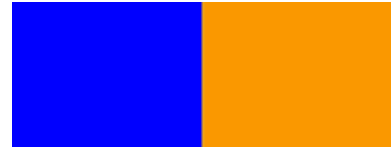
The different values in the blue scale at the left match the values in the grey scale at the right.

Comparing Values of Colors

The following pairs of colors illustrate comparative value relationships.



The yellow is a lighter value than the red.



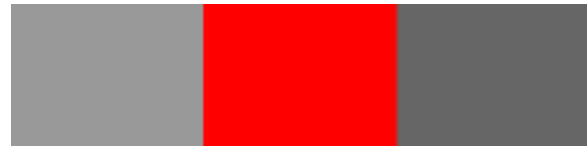
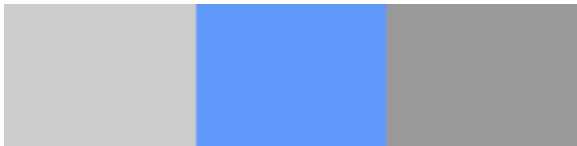
The blue is a darker value than the orange.



The green is a lighter value than the brown.



The dark green is equal in value to the brown.



Compare the blue and red rectangles to the gray rectangles on either side of each color. Which gray is equal in value to the color? It may be helpful to stand at a distance and blur your eyes. If the edge between the two areas disappears, the values are equal

Value Matching Tests



Equal value

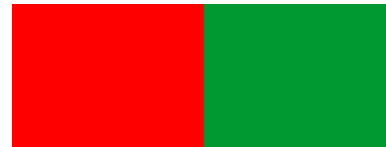


Equal value

Seeing the difference between two different colors is more difficult than seeing the difference between a color and neutral gray.



Blue and tan are the same value.



Red and green are the same value.



Compare the yellow rectangle to the gray rectangles on either side of it.
The value of yellow is extremely high.

Why value matters

Seeing the relative differences in the lightness and darkness of colors is an absolute requirement for successful design. Value not only plays a pivotal role in creating color harmonies and spatial effects, but it also determines the readability of text.

These examples demonstrate the relationship of the values of colored forms to the values of two different backgrounds.



The white background creates sufficient contrast for all the colors except for yellow.
The dark background creates sufficient contrast for all the colors except for brown and blue.
View from a distance for the most accurate reading.

Why value and text matter

Using text as an example, these illustrations demonstrate legibility failures caused by insufficient contrast between text and background colors.

Egg yoks In Italy's Pledmont region are bright orange red.

A spider's blood turns blue when exposed to oxygen.

Abraham Lincoln had dark grey eyes.

Sales of blue vodka increased 200% in the USA.

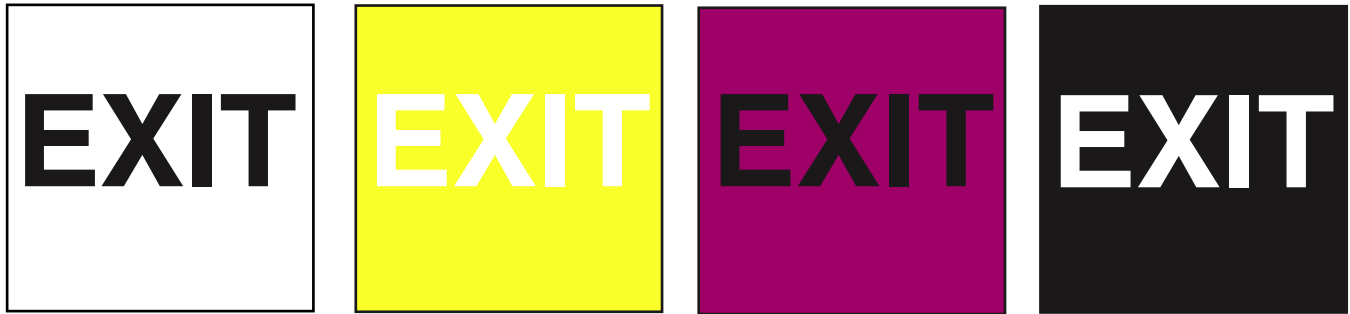
Software manuals frequently use this poor contrast between background and text.

The illustrations below show how low value contrast combined with low saturation contrast cause the most severe problems for legible text.

South Dakota's Black Hills are green.

The color red is in four out of five national flags.

When the issue is visibility, the answer is high value contrast. The Americans with Disabilities Act, (legislation in effect in the United States) requires high contrasts between light and dark colors on all signage so that the visually disabled can see this information. Compare the differences in high and low contrast on the "Exit" signs below.



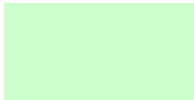
Furthermore, text in a rainbow of colors can be problematic. Don't make this mistake.

SEVEN COLOR RULES

TINTS, TONES & SHADES



Saturation variations of a pure color, such as green, can be defined by several terms.



TINT

A color mixed with white



tone

A color mixed with gray



SHADE*

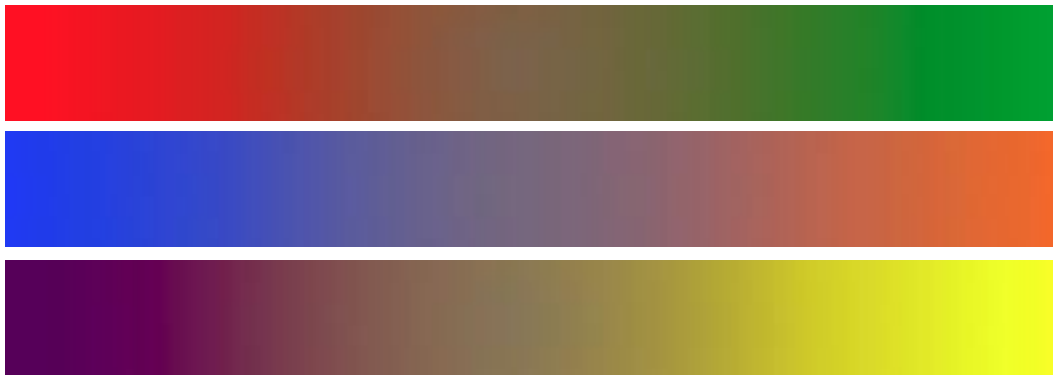
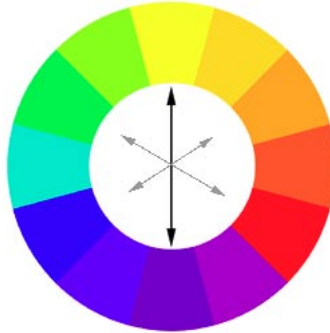
A color mixed with black

Tints, tones and shades are examples of less pure, less saturated colors.

** Sometimes the term "shade" implies any variation of a color. For example, "What shade of red is the color?" could imply "What variation of red is the color?"*

COMPLEMENTARY COLORS

Fundamental complementary colors are colors which are opposite each other on the color wheel.
When mixed together they create grey or a neutral hue.



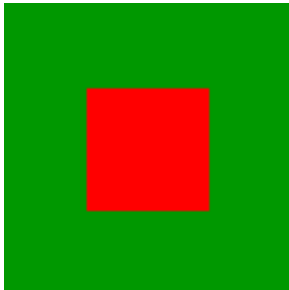
Adding the complement to any color creates a wide range of complex muted hues.

Fundamental Complementary Colors

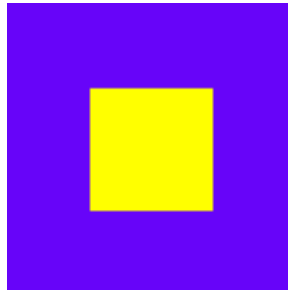
Fundamental complementaries correspond to the subtractive color system which artists use. They are based on visual relationships. In the judgement of the eye, they complete each other.

When complementary hues are adjacent to each other, they create harmonious relationships and incite each other to maximum brilliance. They are like two ends of a balancing scale, holding each other in equilibrium. Lowering their saturation lessens the contrast but maintains the balance.

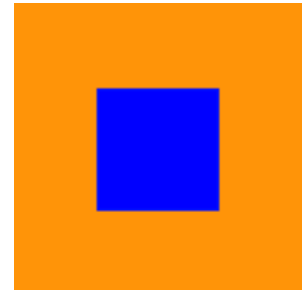
In addition to being harmonious, these primary complementary pairs exhibit other characteristics:



Red and green create a contrast of equal value



Yellow and purple create a light and dark contrast.



Blue and orange create a warm/cool contrast.

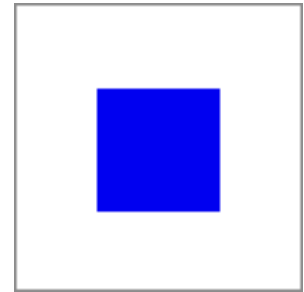
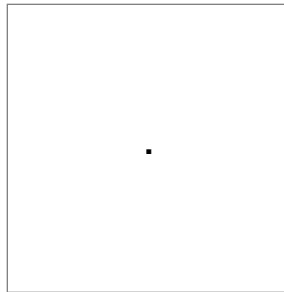
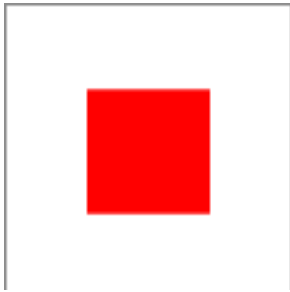
Generative Complementary Colors

Generative complements correspond to the additive color system which scientists use.

When combined these two colors produce white or gray. Examples of complementary pairs are red and blue-green, yellow and blue. These correspond to the physiological complements generated by the human eye, a phenomenon known as "simultaneous contrast." For any given color, the eye simultaneously requires the complementary color and creates it, even if the color is not physically present.

This phenomenon can be demonstrated by the "after image" tests below.

Begin by looking at the red square at a very close distance. Cup your hands around your eyes to block out any distractions. Stare at the center of the red square for 30 seconds. Next, move your eyes to the center of the pure white square. Hold your eyes steady on the black dot. You will see the "after image" color. Repeat for the blue square.



COLOR HARMONY

HARMONY DEFINED

HARMONIES & NON-HARMONIES

HARMONY GUIDELINES

COLOR HARMONY DIAGRAMS

ANALOGOUS HARMONY

COMPLEMENTARY HARMONY

SPLIT COMPLEMENTARY HARMONY

TRIAD HARMONY

OTHER COLOR WHEEL HARMONIES

BLACK AND WHITE HARMONY

HARMONY DEFINED

The challenge of all designers can be summed up in one sentence:

We are faced with an inequality of shapes and colors.

The goal is to achieve balance - - not symmetry, but balance.

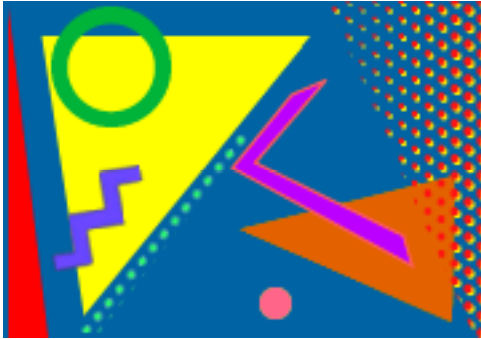
Balance exists as a mid-point between monotonous and chaotic design. The human brain will reject under-stimulating information. The visual task requires that we sustain visual interest. The human brain will also reject what it can not organize, what it can not understand. Color harmony delivers a sense of order.

In summary, extreme unity leads to under-stimulation, extreme complexity leads to over-stimulation. Harmony is a dynamic equilibrium. It implies connections with accents, not jolts.



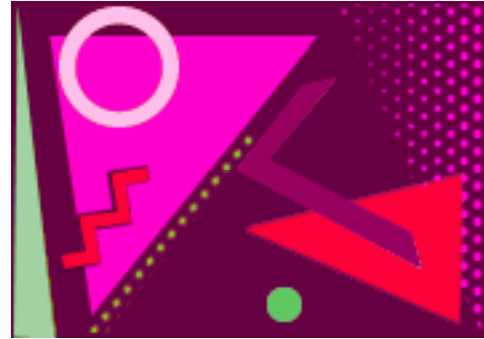
Harmony can be defined as a pleasing arrangement of parts, whether it be music, poetry, color, or even an ice cream sundae.

HARMONIES & NON-HARMONIES



CHAOTIC

There are too many colors. Harmony requires a sense of order & balance.



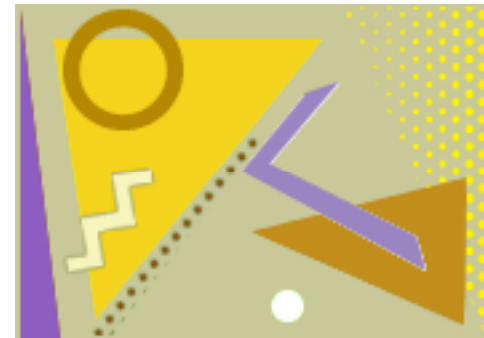
HARMONIOUS

Pure colors & strong value contrasts create a successful dynamic effect



MONOTONOUS

All the colors are muted, all the values, similar. Harmony requires contrast.



HARMONIOUS

Muted and pure colors with close values create a subtler harmony.

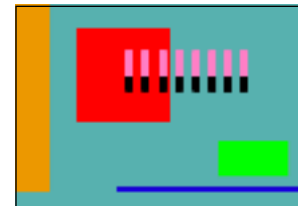
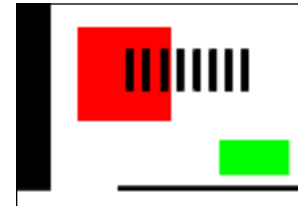
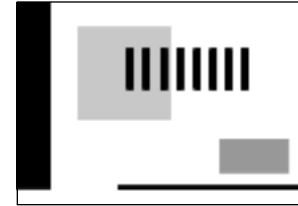
HARMONY GUIDELINES

While no color scheme holds universal appeal, some guidelines for success are worth noting:

1. A good color scheme uses only a few colors, properly selected and blended. Use restraint. Amateurs use too many colors.
2. A little bit of color goes a long way. Using one variation of a color in only one area is a surprise. Don't repeat every color in the design.
3. Use an established harmonious color chord. A combination of warm and cool colors works best.
4. Experiment with dynamic and subtle color harmonies. Choose the best approach for your design. Dynamic harmonies with strong contrasts are attention-getting and energizing. Subtle harmonies with low contrasts are more fluid and low key. In some instances they are more sophisticated.

Guidelines for Dynamic Color Harmonies

1. Before you select any colors, create a thumbnail of the design in black, white and greys. Analyze the light and dark relationships and plan your areas of strongest value contrasts.
2. Use highly saturated colors and strong value contrasts, such as a very light background and darker shapes. If text is part of your design, readability depends on maximum value contrasts.
3. Stick to established color harmonies and don't overdo it. Most beginners make the mistake of using too many colors. More is less. Less is more. The example at the right is confusing. Similar to bad music, it is "untuned."
4. For innovative color harmonies, find an example of a dynamic color scheme in nature, the fine arts, print media, textiles, or other design sources. Use this as a departure point and resist the temptation to add other colors.



Guidelines for Subtle Color Harmonies

1. Before you select any colors, create a thumbnail of the design in black, white and greys. The values of all large shapes and the background should be close. Design easy transitions between them.



2. Select muted colors in a medium to high value range for the large areas. The more colors you use, the closer the values should be. Place these hues in the dominant areas first.



3. Create accents with value contrasts. Small quantities of much darker or lighter colors break the monotony of the close values used on the large forms and create visual interest.



4. Create accents with a pure color. Include a small area of a highly saturated version of at least one of the muted colors. This contrast will enliven the design.

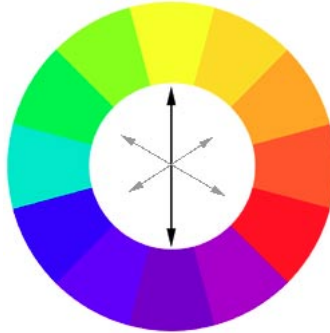


COLOR HARMONY DIAGRAMS



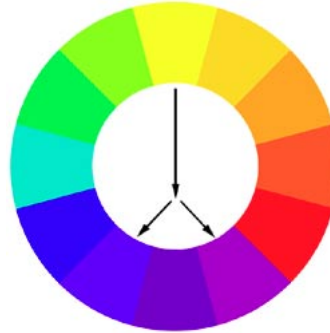
ANALOGOUS

Any three colors which are side by side on a 12 part color wheel, such as yellow-green, yellow, and yellow-orange. Usually one of the three colors predominates.



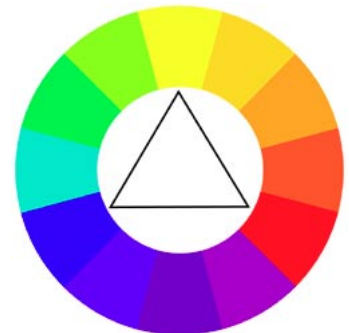
COMPLEMENTARY

Any two colors which are directly opposite each other, such as red and green. Maximum contrast and maximum stability. Lowering the saturation lessens the contrast but maintains the balance.



SPLIT COMPLEMENTARY

One color plus the two colors on either side of its complement, such as yellow plus red-purple and blue-purple. This harmony softens the contrast of the complementary color scheme.



TRIAD

Any three colors which are equidistant from each other, such as yellow, red and blue. These colors form an equilateral triangle.

Examples ▶

Examples ▶

Examples ▶

Examples ▶



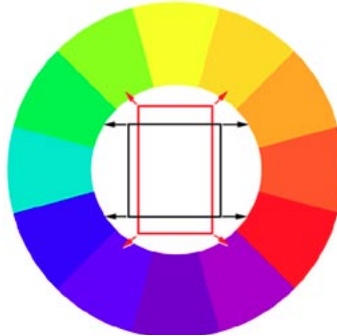
COLOR HARMONY DIAGRAMS



ANALOGOUS PLUS COMPLEMENT

Analogous colors and the complement of the central analogous hue, for example yellow-green, yellow, yellow-orange and purple.

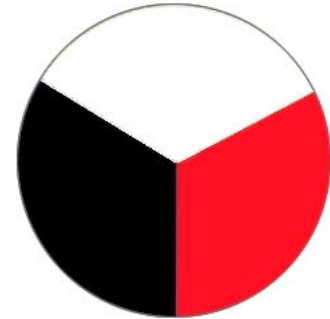
Examples ▶



TETRADS

Two pairs of complementary colors whose positions form either a square or a rectangle, such as yellow-green and red-purple, yellow-orange and blue-purple.

Examples ▶



BLACK AND WHITE PLUS ONE COLOR

Any one color in combination with black, white and/or gray, such as red, white and black.

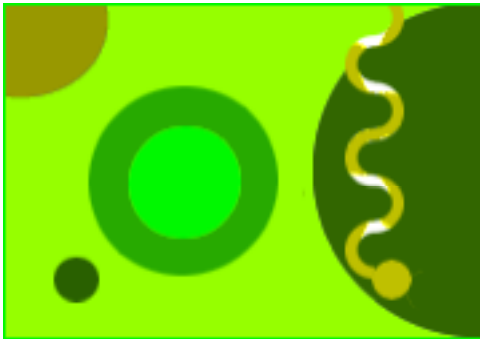
Examples ▶

ANALOGOUS HARMONY

Examples of possible combinations



Color Wheel Diagram ▶

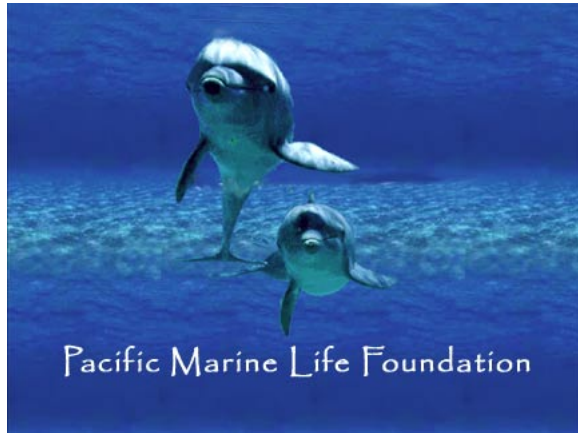


A dynamic harmony based on strong value contrasts and saturated colors.



A subtle harmony based on closer values and less saturated colors.

Design Examples - Analogous Harmonies



Web Home Page
Blue and blue-green



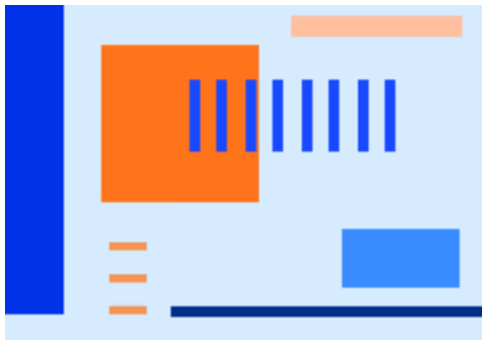
PowerPoint Slide
Yellow, yellow-green, and green

COMPLEMENTARY HARMONY

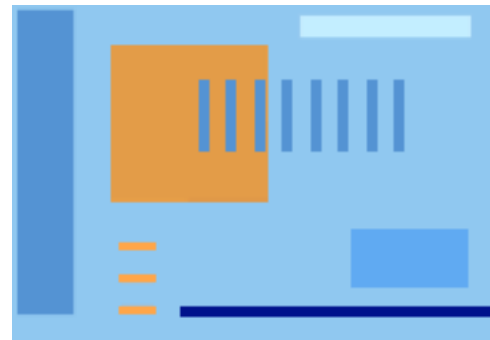
Examples of possible combinations



Color Wheel Diagram ▶



A dynamic harmony based on strong value contrasts and saturated colors.



A subtle harmony based on closer values and less saturated colors.

Design Examples - Complementary Harmonies



Web Page
Yellow-green and red-purple



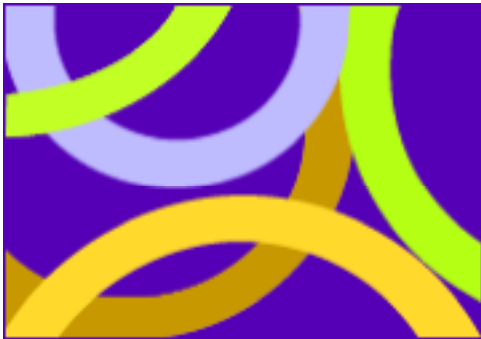
PowerPoint Slide
Blue and orange

SPLIT COMPLEMENTARY HARMONY

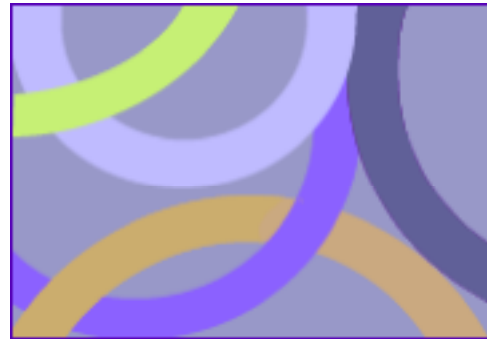
Examples of possible combinations



Color Wheel Diagram ▶



A dynamic harmony based on strong value contrasts and saturated colors.



A subtle harmony based on closer values and less saturated colors.

Design Examples - Split Complementary Harmonies



Web Page
Blue, yellow-orange, and orange



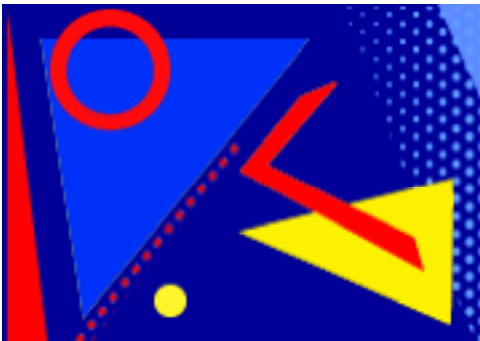
PowerPoint Slide
Purple, yellow-green, and yellow orange

TRIAD HARMONY

Examples of possible combinations



Color Wheel Diagram ►

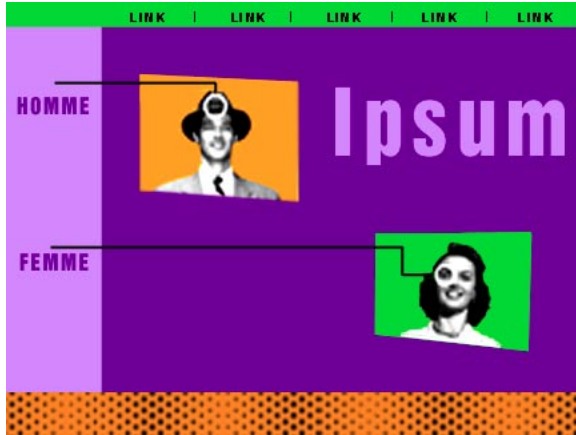


A dynamic harmony based on strong value contrasts and saturated colors.

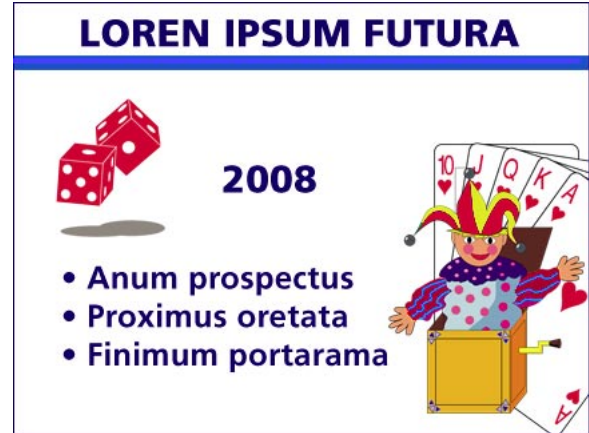


A subtle harmony based on closer values and less saturated colors.

Design Examples - Triad Harmonies



Web Page
Purple, orange, and green



PowerPoint Slide
Blue, yellow, and red

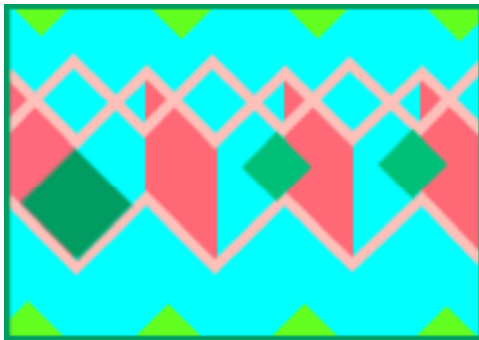
OTHER HARMONIES

ANALOGOUS PLUS COMPLEMENT

Examples of possible combinations



Color Wheel Diagram ▶



A dynamic harmony based on highly saturated colors and value contrasts.

TETRAD

Examples of possible combinations



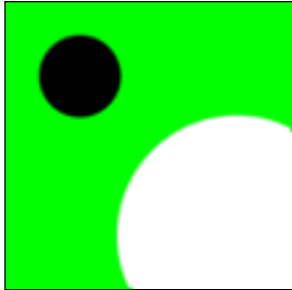
Color Wheel Diagram ▶



A dynamic harmony based on highly saturated colors and value contrasts.

BLACK & WHITE HARMONY

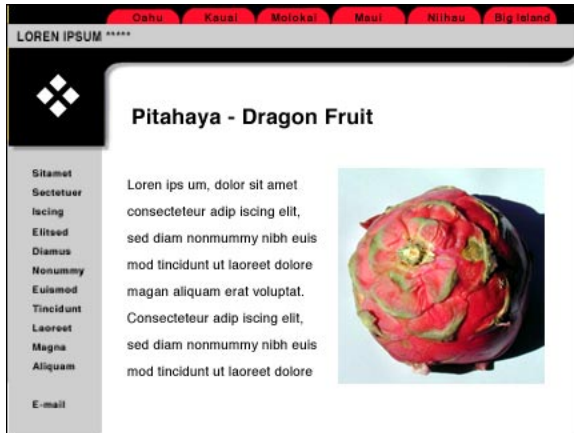
Black and white plus any one color create a harmony.
Grey can also be added to this basic color harmony formula.



These harmonies are inherently dynamic due to the high contrasts between dark and light, chromatic color and achromatic color.

Note: Very light and very muted colors are not as successful.

Design Examples - Black and White Harmonies



Web Page
Black, grey, white, and red



PowerPoint Slide
Black, grey, white, and colored image

COLOR EFFECTS

INTRODUCTION

SUBSTANCE & SURFACE

COLOR INTERACTION

AREA & QUANTITY

MOVEMENT

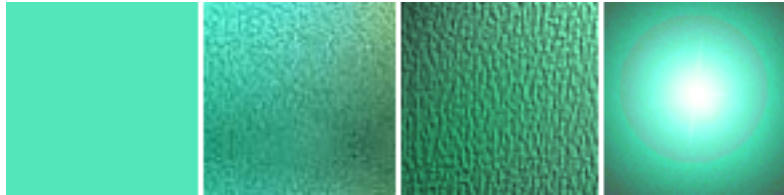
INTRODUCTION

When we experience color, it is always relative to its context. With the exception of the sky, the only unbounded form in our environment, color is part of a form, one which may be angular or curved, concave or convex, large or small. The surface of this form also has certain characteristics. It may be smooth and shiny or roughly textured. At the same time, this colored form is part of a spatial arrangement of other colored forms, each with its own specific characteristics. All these relationships will be interacting simultaneously and casting their influence on our perceptions. As a result, color creates paradoxes and ambiguities. It mutates, it moves, it changes everything around it. It is the most relative of all the elements of visual communication.



SUBSTANCE & SURFACE

Color may exist as either light or pigment on a tangible surface. Pure colors are extremely luminous in the RGB color model used in computers. Others, such as the additive tertiary, orange, lack the vibrancy of the painter's tube of Cadmium Orange. In paint and some print media, iridescence and metallic surfaces are possible. In digital media, these effects can only be achieved by illusion. Likewise, colors in paint and print can only mimic the pure glow of light. As a final comparison, the color resulting from the tangible texture of a real object can only be created by illusion in paint, print, and light.



In the world of surface color, the transparency or opacity of the material will play a role in our perception of color effects. Furthermore, the textural characteristics of the surface are influential. Shiny and smooth surfaces reflect more light and will appear lighter. Dull and textured surfaces diffuse light and will appear darker.

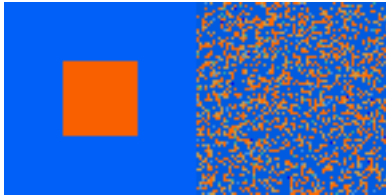
COLOR INTERACTION

The relativity of color can be demonstrated by observing the effects colors have on each other. The relationship of values, saturations and the warmth or coolness of respective hues can cause noticeable differences in our perception of color.

During the past 150 years, several notable color theorists have studied these effects. This section will include information about the findings of Michel Chevreul, Wilhelm von Bezold, Josef Albers and Johannes Itten.

Chevreul's Theories

Chevreul (1786-1889), a chemist and director of a dye house in Paris, left a lasting impact on color theory. The following explains his principles of the visual effects of color:



1. Highly contrasting colors, used in sufficient quantities, will not change their optical hue and will make each other appear more brilliant. When present in small quantities, they will blend and create a duller new color. View this example at a distance to see the effect.



2. If colors are a little farther apart, not analogous and not complementary, one color will give the adjacent color a complementary tinge. In the example above, yellow next to a green gives the green a violet tinge.



3. Colors adjacent to each other on the wheel tend to blend into each other and optically mix to create a new color. View these examples at a distance to see the effect. Chevreul also noted that analogous color schemes work best when the key hue is a primary.

The Bezold Effect

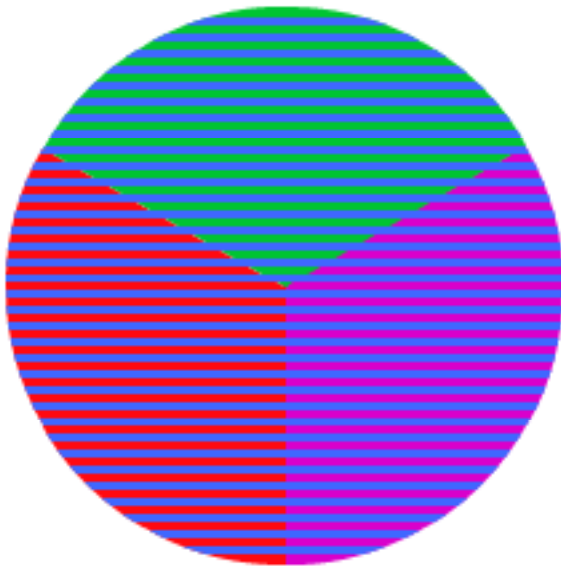
Wilhelm von Bezold, a nineteenth-century rug designer, found that changing only one color in a design alters its entire appearance.



The dominant background color is changed from a bright yellow to black. All other colors remain the same. As a result, different colors, forms and patterns become more or less predominant in each composition.

Bezold and Chevreul

In these "Bezold Effect" examples, the three colored areas on each circular form remain the same. Only the color of the stripes changes from blue at the left to yellow on the right. Chevreul's theories explain these color effects.



View these from near and far.

Albers & Color Metamorphosis

The color theorist Josef Albers (1888-1976), a member of the Bauhaus school of art and industrial design, focused on the interaction and relativity of color. These studies were documented in his book, *Interaction of Color*.

The examples on the following pages demonstrate how the same color will evoke different readings of its perceived hue, a metamorphosis which is caused by its surroundings. Individual perceptions may vary.

Similar color contextual mutations can be created with colored paper such as "Color-aid" or in graphic software such as Adobe Photoshop®.

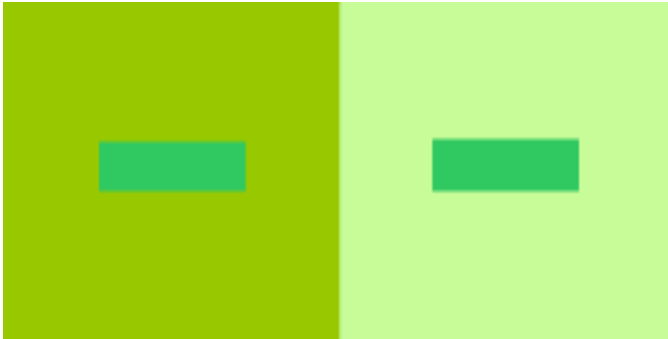
Note:

1. All the colors used in the color mutations on the next four pages are derived from the 216 color palette which is used by both Macintosh and PC's running Windows 3.1, 95 and 98.
2. RGB values for these hues are supplied as reference.
3. Printing these pages may result in different color readings.
4. The examples should be viewed on a system with full gamma correction.



Different readings of the same color

3 colors look like 4



The small green rectangle on the left appears to have a slight bluish tinge when compared to the green on the right.

RGB Values:

Left: R: 153 G: 204 B: 000

Right: R: 204 G: 255 B: 153

Center: R: 051 G: 204 B: 102



The small gray rectangle on the left appears to have a yellow tinge when compared to the gray on the right.

RGB Values:

Left: R: 051 G: 153 B: 205

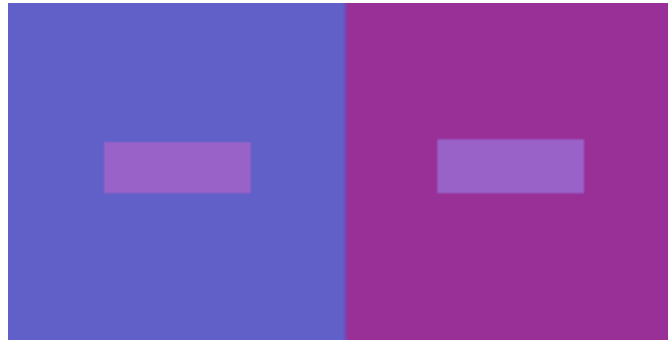
Right: R: 000 G: 102 B: 102

Center: R: 102 G: 153 B: 153



PROOF: Block out the middle portion to see the same effects as the larger examples.

3 colors look like 4



The small purple rectangle on the left appears to have a red-purple tinge when compared to the purple on the right.

RGB Values:

Left: R: 102 G: 102 B: 204

Right: R: 153 G: 051 B: 153

Center: R: 153 G: 102 B: 204



These mutations can be explained by the "Vampire Effect." The small purple rectangle is a combination of blue and red. The large blue-purple square at the left sucks the blueness out of the purple and leaves behind a red-purple. The large red-purple square at the right sucks the red out of the purple and leaves behind a blue-purple.

Different readings of the same color

3 colors look like 2



This color mutation is also known as a "reverse ground" effect. The mutating color on one side of the diagonal line almost matches the background of the square on the opposite side. The "Vampire Effect" applies to these color shifts.

RGB Values:

Left: R: 051 G: 204 B: 255

Right: R: 000 G: 255 B: 204

Center: R: 102 G: 153 B: 153

RGB Values:

Left: R: 153 G: 051 B: 255

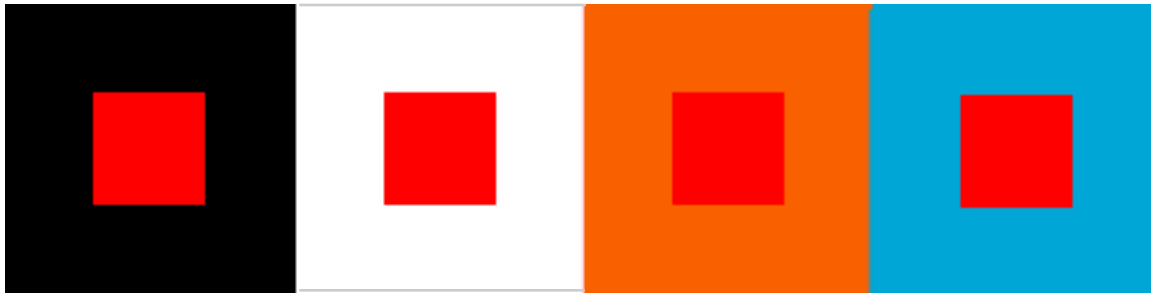
Right: R: 102 G: 102 B: 255

Center: R: 102 G: 051 B: 255

Itten & Color Contrasts

Johanne Itten (1889-1967), another member of the Bauhaus, developed theories about color contrasts. In his book, *The Elements of Color*, he documents several kinds of color contrasts: hue, value, saturation, warm and cool, complementary, simultaneous and quantity.

Compare the contrast effects of different color backgrounds for the same red square.



Red appears more brilliant against a black background and somewhat duller against the white background. In contrast with orange, the red appears lifeless; in contrast with its generative complement, blue-green, it exhibits brilliance. Notice that the red square appears larger on black than on other background colors.

AREA & QUANTITY

Different effects occur when colors occupy different areas in a composition. When a specific color is placed in one area, its behavior is relative to the surrounding colors and forms. Changing its location changes the effects. As a rule, any configuration of colors will strive toward contrast or assimilation. Colors will cluster by their mutual characteristics. Those with similar values, saturations and temperatures will group together. Colors will oppose one another as clusters in spite of their actual location in space.

The quantity of the color also creates different effects. The design principle of emphasis and subordination are at work in all arrangements of colors and forms.

Area Distribution

The area a color occupies will alter the effects of a design. These examples are based on the same composition and the same four colors. Only the placement of the color changes.



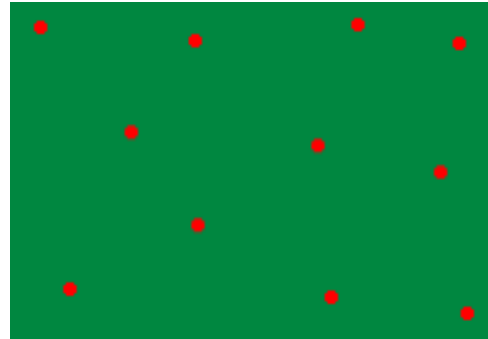
Notice how similar values cluster and how different forms become dominant.

Concentration or Dispersion

The quantity of a color is influential. If a color is concentrated in one main area, the effect is quite different from being dispersed throughout the composition.



The red form is a powerful focal point. Red and its complement, green, occupy almost equal areas in the composition. The total effect is a dynamic equilibrium.



Red is scattered in small quantities and becomes extremely active. Placing another colored form in this field would alter the entire effect.

MOVEMENT

Optics - the physiological basis for the movement of color



1. Red focuses behind the retina. Therefore, the lens grows more convex to pull it forward.
2. Blue is sharply refracted. This causes the lens to flatten out and pushes the blue image back. We perceive that blue areas are receding and smaller.

Tangency - the physical basis for the movement of color

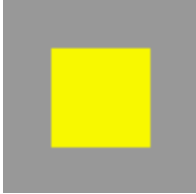


Any form that overlaps another form is perceived to be in front of that form.

In spite of this physical placement, color possesses the ability to advance or recede, to vibrate or stabilize, collapse inward or bulge outward. The next nine pages cover a wide range of factors that create this phenomenal characteristic of color.

The Movement of Colors

When colors are isolated by gray, the following characteristics of movement can be defined.



Yellow is the most visible and illuminating of all colors.
It appears to be radiating from within. It moves outward and is difficult to contain.



Red is aggressive.
Simultaneously it vibrates within the area it occupies and advances.



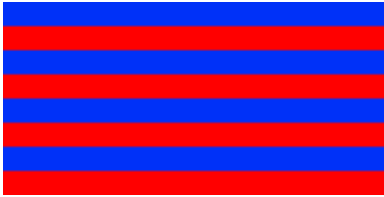
Blue is relatively stable and moves inward.



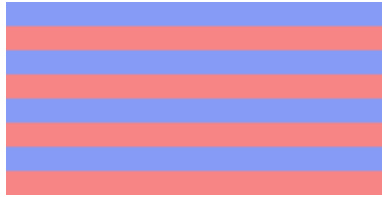
Green is tranquil and rotates towards the center.

Comparative Movement of Colors

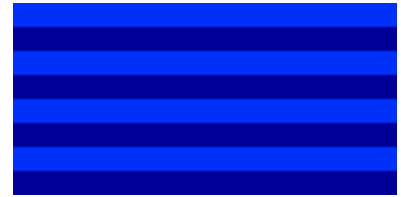
When colors exist in equal relationships with other colors, the following characteristics apply:



Warm colors advance.
Cool colors recede.



Warm colors advance, even
when values are changed, as
long as the values are close.



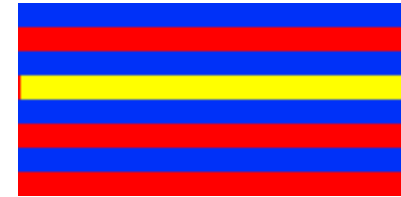
Lighter values advance.
Darker values recede.



Colors with the highest
saturation advance.
Lower saturations recede.



Colors with the highest
saturation advance, even
when they are warm & cool.



The area of the highest
contrast advances while
other areas recede.

Movement

Emphasis and Subordination

Every image contains a hierarchy of dominant and less dominant features. The formal term for this effect is “emphasis and subordination.” It can be likened to a star on a stage and a supporting cast.

Aside from the fact that the largest elements are dominant, color is the most effective tool available to control the focal point. As previously described, advancing colors attract the most attention and are therefore dominant (if size and shape are the same). Recessive colors are subordinate.

Emphasis and subordination theories can be further explained by applying them to the relationship between a photograph and a frame or background color. The examples on the next pages illustrate how the right colors draw attention to important areas and how the wrong colors may distract or overwhelm the image.

Emphasis and Subordination

Frames, Mats, and Background Colors

The most common mistake is a background (or frame) color that dominates the image.
Compare the effects below:



Bright colored backgrounds dominate images. A background color that is more muted than the colors in the image keeps the emphasis on the image.



Light muted backgrounds are subordinate. The emphasis is on the photograph. Notice how the colors in the image appear brighter.

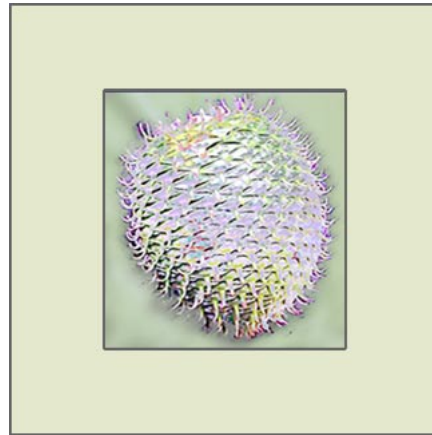


Dark backgrounds may be suitable for most images. Dark colors recede, lighter colors advance. Notice how the colors in the image appear brighter.

Very light images are easily dominated by the wrong colors.
Dark and bright backgrounds dominate delicate hues. Light and muted backgrounds are best.



Dark and vivid colored backgrounds are extremely dominant and overwhelm light images. The eye can't focus on the light details in the photograph.

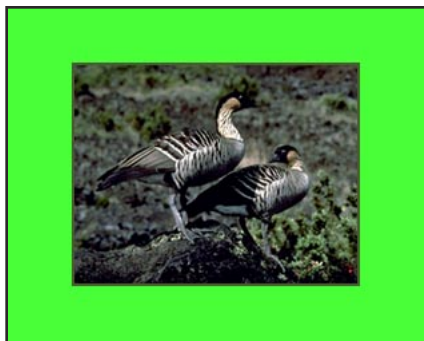


White or light backgrounds are very successful. The emphasis is on the image. Consequently, the colors in the image appear more vivid and details more apparent.

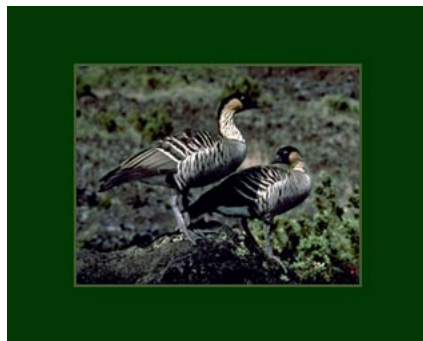


Muted background colors that are slightly darker than the image can be successful. Select the color that occurs in the greatest amount in the image and use a muted and darker version of it – or a muted and darker shade of its complement.

Very dark images are also easily dominated by the wrong colors.
Dark backgrounds are successful; light and bright backgrounds unsuccessful.



Bright colored backgrounds dominate and overwhelm dark images. They advance and make it impossible for the eye to focus on the dark details in the photograph.



Dark muted backgrounds are recessive and subordinate. The photograph becomes the focal point. An added benefit is that the dark details in the image appear lighter and more vivid.



White (or very light) backgrounds advance and may make a dark image appear even darker. Large areas of white may also make it difficult to detect details in the image.

Movement

Color and Shape

All shapes advance.

Two-dimensional designs consist of a "figure-ground" relationship. Shapes are the figuration, the negative space or background is the ground.

Angular (geometric) forms advance the most and curved (organic) forms the least.



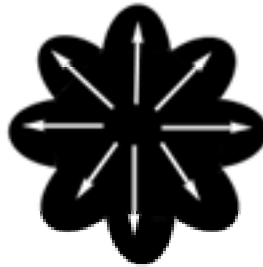
In spite of the fact that the background color is a very saturated warm hue and the foreground shapes are cool, a figure-ground relationship exists. Therefore, all forms advance, regardless of the colors involved. Varying degrees of ambiguity may occur when curved shapes are warm and bright and angular shapes are cool and less saturated.

Movement Color and Shape

Concave and convex shapes embody specific characteristics of movement.



Concave shapes are passive and move inward.



Convex shapes are aggressive and push outward.



Concave/convex shapes combine these forces.



When the forms are muted blue and the background bright orange, the effects persist.

Movement

The Illusion of Transparency

The illusion of transparency can be created by a third color derived from the two basic colors. The intersecting area communicates information about the spatial positioning of the two colors.



1.
Yellow is in front of blue.



2.
Yellow is in front of blue
and closer to it than the
first example



3.
Yellow and blue are on
the same spatial plane.

Movement & Placement of Color

The lower portion of a composition is perceived as "figure" or shape, while the upper portion is read as "ground" or background. The color that occupies the lower portion of the layout below will advance.



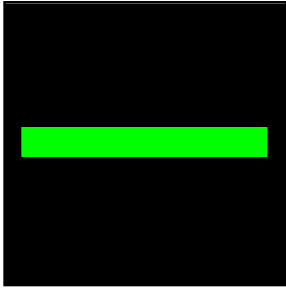
This effect stems from our experiences of the natural landscape. The receding sky exists in the upper area of our field of vision, land and advancing forms are below.



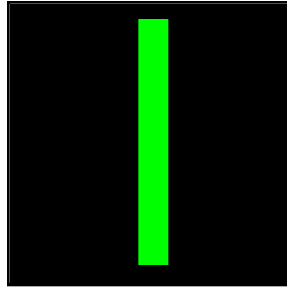
Warm and cool colors with equivalent values and saturation demonstrate this effect. Some ambiguity appears in the example on the right.

Movement and Axes

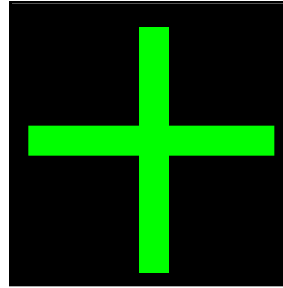
The primary axis of a form plays a role in its movement in space.



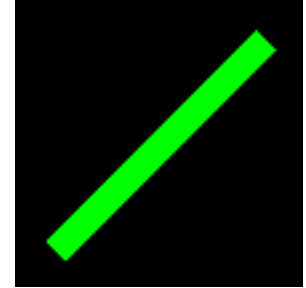
A horizontal axis
is stable



A vertical axis
contains potential
for movement.



A combination of
horizontal & vertical
is the most stable.



A diagonal axis
is the most dynamic.

Applying highly saturated warm hues to horizontal forms and cool muted hues to angular shapes may create varying degrees of ambiguous effects.

Movement

Time and Space

Color creates reactions which affect our perception of time in visual space.
Bright hues stop the eye and isolate themselves from the surroundings.

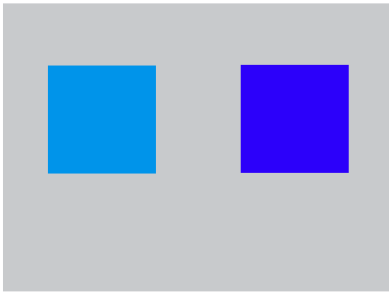


Red is the most powerful, a light desaturated blue is the most passive, and yellow radiates.

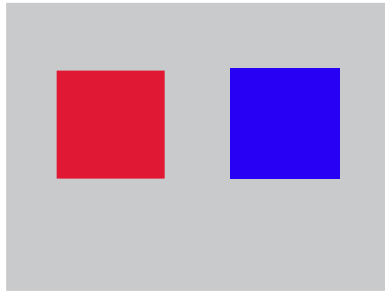
Movement

Color and Weight

Colors possess qualities of heaviness or lightness relative to other forms and the placement of those forms in a composition. Heaviness descends. Lightness stays fixed or ascends.



Dark colors are heavier than lighter colors.



If hues are the same intensity and value, warm will be heavier.



Light, less saturated colors are less dense.

IN CONCLUSION

Color is multi-dimensional. Intangible as it is, it affects everything around it and even turns on itself and mutates in endless ways.

This publication has presented criteria for evaluating the primary characteristics of color. The first section defined the basic terminology of color, the second explored harmonious chromatic relationships, and the final section presented the contextual relationships and three-dimensional effects of color. Knowledge of all these characteristics is a powerful tool for successful web site design. It is recommended that these concepts be used as exercises for each individual's mastery of color design.

A bibliography is provided for further exploration.

BIBLIOGRAPHY

Four essential books

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2. Arnheim, Rudolf, ART AND VISUAL PERCEPTION, University of California Press
3. Itten, Johannes, THE ELEMENTS OF COLOR, Van Norstrand Reinhold
4. Swirnoff, Lois, DIMENSIONAL COLOR, Van Norstrand Reinhold



About the author

Jill Morton is a color consultant whose clientele include industry giants Nokia and Kodak. Since 1995, she has also been actively involved in web site and user-interface design.

She received a Masters Degree in the Fine Arts and has served as faculty at the School of Architecture, University of Hawaii, Chaminade University and Matsuda Technology Center.

In addition to writing and illustrating Color Voodoo books, she also maintains an on-line resource for color information at Color Matters - <http://www.colormatters.com/>



eBook Publications from Colorcom

Color Voodoo - <http://www.colorvoodoo.com>

Colorcom Publishing - <http://www.colorcom.com/colorpub.html>

A Guide to Color Symbolism

(Color Voodoo #1)

Global Color: Clues and Taboos

(Color Voodoo #2)

50 Symbolic Color Schemes

(Color Voodoo #3)

Color Logic

(Color Voodoo #4)

Color Logic for Web Site Design

(Color Voodoo #5)

Color Voodoo for the Office

(Color Voodoo #6)

Color Logic for PowerPoint®

(Color Voodoo #8)

Colors that Sell: Tried and Tested Color Schemes

(Color Voodoo #9)

Color Voodoo for Your Closet

(Color Voodoo #10)

Color Matters for the Home

(Color Matters series)

Color Matters

(eBook of the Color Matters website)